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MAJ RICHARD C. SAVAGE

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Analysis of variance in the 18-30 μm water vapor sensing channels of the DMSP SSH infrared sounder indicates the channels are too opaque in moist atmospheres. Their statistical influence must be carefully controlled in forming statistical inversion matrices for temperature profiles.

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PREFACE

The military weather and oceanographic organizations share with other environmental agencies a need for information on the vertical temperature and moisture structure of the atmosphere. This document examines success thus far in analyzing temperature and moisture profiles based on radiance measurements from the SSH, a multi-spectral infrared special sensor on the Defense Meteorological Satellite Program (DMSP) spacecraft. The document is of probable interest to meteorological agencies concerned with the production or use of satellite soundings.

Analysis of results thus far indicates the 18-30 μm water vapor channels used in the SSH are too opaque to yield much information in moist atmospheres, and that the most transparent subset should be used.

Major Richard C. Savage
28 March 1980

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1. INTRODUCTION

AFGWC/TSI was tasked to evaluate the use of soundings of atmospheric temperature and water vapor derived from the Defense Meteorological Satellite Program (DMSP) special sensor H (SSH) in the Point Analysis program (PA). PA is designed to provide information necessary for the calculation of atmospheric transmissivity and refractive index in several parts of the electromagnetic spectrum. For this reason, water vapor content is an important variable. The microwave sounder (SSMT) on DMSP has no H_2O vapor sensing capability; accordingly, it was not extensively considered for this application. Likewise, it was noted that the TIROS Operational Vertical Sounder (TOVS) has a water vapor sensing capability, but the water vapor information is not decoded from the bulletins transmitted to AFGWC from NESS. NESS does not derive water vapor profiles, but rather integrated water vapor content in the lower, middle, and upper troposphere. TOVS incorporates the 6.7 μm band for these measurements. The infrared channels used in the SSH instrument are listed in Table 1; note that the water vapor channels are in the 18-25 μm band of H_2O absorption. This band is more opaque than the 6.7 μm band used by TOVS.

2. DEVELOPMENT EFFORTS

It is commonly accepted at this time that an algorithm for the deduction of temperature and moisture from infrared radiance observations, based on explicit physical methods - i.e., the radiative transfer equation - does not work. AFGL/OPI, in response to AWS Geophysical Requirement 1-78, is pursuing this aspect of the problem. Further details may be found in AFGL-TR-79-0100, "An Atmospheric Temperature Profile Measured with an In-Situ Infrared Radiometer" by McClatchey and D'Agati. For this reason, both NESS and AFGWC have resorted to the use of statistical retrieval methods, which are described further below.

AFGL was also asked to explore the possibility of an immediate retrieval of atmospheric transmissivity (or optical depth) from the observed radiance set, rather than through the present roundabout method of processing radiances through an algorithm to produce a temperature/moisture profile, and then entering the derived profile into a transmission model (e.g., LOWTRAN). Their final answer is not available, due to the difficulty noted in the previous paragraph.

AFGWC/TSI attempted a development effort in May 1979, aimed at the deduction of transmissivity from infrared radiances calculated through the same radiative

transfer model used operationally by our customers. The radiances were calculated from a large, statistically representative set of temperature/dewpoint profiles obtained from NESS. The effort failed, for at least two reasons we can identify:

a. The temperature/moisture profile set used contained no specification of skin temperature at the surface. We assumed skin temperatures equal to 1000 mb temperatures, which were reported. This is apparently not adequate.

b. The LOWTRAN model is probably not of adequate spectral resolution for the task attempted. (It is also probably not adequate for the use the customers are making of it, but that is beyond our responsibility.) We found the statistical relationship between radiosonde profiles and modeled radiances at 725 cm^{-1} and 747 cm^{-1} did not agree with relationships based on observed radiances and coincident radiosondes. Personnel of NEPRF, attempting to process SSH data with a physical algorithm, have also found this disagreement.

3. CURRENT PROCESSING PROCEDURES

The present processing of SSH radiances (program HPKG) relies on the statistical eigenvector technique (SET), developed by Smith and Woolf. In the SET, an inversion matrix is formed from a data base of observed radiances and coincident radiosonde balloons. The two are related by:

$$(T - \bar{T}) = C\ (T_B - \bar{T}_B) \qquad (1)$$

in which T and $\bar{T}$ are observed and mean temperature and dewpoint profiles, T_B and $\bar{T}_B$ are observed and mean brightness temperature vectors, and C is the coefficient matrix relating the two. (Brightness temperatures are derived from radiances through the Planck function.) The production of useful temperature/dewpoint profiles depends on the capability of the instrument to capture the necessary information in the form of brightness temperatures (or radiances), and our ability to manipulate that information by the formation of adequate C matrices. Both aspects of this problem will be discussed in the following paragraphs.

4. RESULTS/PROBLEMS

4.1 <u>Data Variance</u>

4.1.1 Moist atmosphere - C matrix 2. In Table 2 are listed several parameters which indicate the information content of data used in the formation of

TABLE 1. SSH CHANNELS

NAME	CENTER WAVENUMBER (cm^{-1})	SPECIES	PEAK RESPONSE (mb)
E1	668	CO_2	30
E2	677	CO_2	70
E3	695	CO_2	150
E4	708	CO_2	350
E5	725	CO_2	500
E6	747	CO_2	1000
E8	835	WINDOW	SURFACE
F8	353	H_2O	400 *
F1	355	H_2O	500 *
F2	397	H_2O	500 *
F7	374	H_2O	500 *
F3	420	H_2O	600 *
F4	442	H_2O	700 *
F6	408	H_2O	850 *
F5	535	H_2O (weak)	SURFACE *

* NOMINAL PEAK IN 1962 STANDARD ATMOSPHERE, BUT VARIABLE DEPENDING ON HUMIDITY PROFILE.

C matrix 2 of satellite 14537, and the quality of results obtained from the matrix, operating on an independent data set. C matrix 2 is based entirely on data (radiosondes and satellite radiances) from the tropics and subtropics, that is, a set of warm, humid soundings. In column 1 are listed the pressure levels, covering the 10 to 1000 mb temperature range and the 300 mb to 1000 mb dewpoint range. Listed in column 2 are the variances (TVAR) of temperature/dewpoint measurements at these levels, as determined by radiosonde balloons. One hundred twenty-three samples were available. After the C matrix was calculated, it was applied to the brightness temperatures of the dependent data set; the residual variance is listed in column 3 (DEPVAR). The error is entirely in the form of variance about a mean error of zero. By applying the C matrix to a sample of independent data, obtained over a twelve day period in December, we determine the error of profiles obtained from independent data. This error has both a mean (BIAS) term, and a random variation (INDVAR), listed in columns 4 and 5, respectively. (The variance in column 5 includes the error contributed by the bias term of column 4.) Listed in column 6 are the brightness temperature variances (TBVAR) of the satellite measurements used in the dependent data set. They are listed in the same order as the listing of peak response shown in Table 1. Several disturbing (and interesting) features emerge from consideration of Table 2. Some of them are discussed below:

a. The largest temperature variance occurs at the 1000, 100, and 10 mb levels, that is, at the surface, the tropopause, and the top of the atmosphere. This variance amounts to approximately 40 squared degrees.

b. All dewpoint variances are larger than the largest temperature variances. The smallest dewpoint variance, some 47 squared degrees, occurs at the 1000 mb level (where temperature variance is a maximum). The largest dewpoint variance, over 120 squared degrees, occurs directly above the minimum, at 850 mb. Very large variances are present at all levels.

c. Although the C matrix does a respectable job of fitting the dependent temperature data (as seen in the remaining variance in column 3), the reduction of dewpoint variance is much less satisfactory (as seen in the variance figures at the bottom of the column). The reduction of dewpoint variance is typically only 50%, but is significantly better at the 1000 mb dewpoint level.

d. Examination of the temperature variance of an independent data set

TABLE 2. C MATRIX 2, SATELLITE 14537

P (mb)	TVAR ($^oC^2$)	DEPVAR ($^oC^2$)	BIAS (^oC)	INDVAR ($^oC^2$)	TBVAR ($^oC^2$)
10	40.6	7.3	0.4	4.4	25.6
20	25.3	3.2	-1.5	10.2	
30	19.7	2.9	1.0	5.3	22.1
50	19.6	2.6	1.2	4.0	
70	29.0	3.6	1.0	10.2	
100	39.2	4.8	1.4	13.0	14.1
150	29.9	7.8	-0.5	7.3	
200	18.5	9.6	-0.1	6.8	
250	13.0	4.8	0.1	5.3	4.2
300	14.6	3.6	0.5	4.8	
400	16.4	2.9	0.7	3.2	
500	14.3	2.0	1.5	5.8	5.8
700	15.3	2.9	0.8	3.6	
850	20.7	6.8	-0.5	24.0	8.3
1000	39.6	12.3	0.6	27.0	30.9
					19.2
300	91.1	60.8	4.4	153.8	18.0
400	100.7	74.0	7.3	59.3	16.4
500	85.0	59.3	6.4	100.0	19.4
700	101.7	53.3	7.2	54.8	18.3
850	121.3	77.4	8.1	94.1	18.2
1000	47.4	15.2	5.2	70.6	18.3
					13.8
	N=123	N=123	N≤29	N≤29	N=123

shows a similar pattern of reduction of variance, except at the 850 mb level. In the case of the dewpoint variances, however, the result is much less satisfactory; at half the dewpoint levels, the variance has been increased. The major reason for this seems to be the large bias error seen in dewpoint temperatures.

e. Examination of the final column shows some puzzling inconsistencies. The variance of brightness temperature is large in the CO_2 channels which have their maximum response near the top of the atmosphere or at the surface, and is less in the channels which respond to mid levels of the atmosphere. But the channels which should respond to water vapor show a uniformly small variance, quite unlike the dynamic variance of the radiosonde dewpoint measurements of column 2. At this point, there arises the question whether the variance indicated by the radiosonde measurements of column 2 is real. Some is probably spurious; radionsonde humidity measurements can be degraded by passage through cloud, for example. Many reports arbitrarily indicate a 30^{o} dewpoint depression as an indication that some moisture is present. However, an effort was made to screen the incoming data, using only measurements from the industrialized nations of North America, western Europe, Australia, Japan, and South Africa. All radiosonde reports used were complete, from the 1000 mb to the 10 mb level, and with dewpoints up to 300 mb. The completeness requirement helps assure a determined effort on the part of the launch crew to obtain the most complete possible profile. With allowance, then, for some amount of (unquantifiable) error in the radiosonde dewpoint variance, we need to inquire whether the SSH instrument is missing something (as indicated by the small variance in its H_2O channels). Fortunately, the question may be answered by consideration of another set of C matrix data - one including large numbers of cold, dry soundings, such as C matrix 6.

4.1.2 Cold atmosphere - C matrix 6. Table 3, organized in the same format as Table 2, shows the parameters of C matrix 6 from satellite 13536. C matrix 6 was originally designed to be representative of the type of atmosphere designated as subarctic Winter in the AFGL catalog of standard atmospheres (C matrix 2 is subtropical summer). As expected, the variances of dewpoint temperatures, shown in column 2, are much less than those of C matrix 2, and are less than, or comparable to, the temperature variances. In spite of this reduction of radiosonde dewpoint variances, some brightness temperature

TABLE 3. C MATRIX 6, SATELLITE 13536

P (mb)	TVAR ($^oC^2$)	DEPVAR ($^oC^2$)	BIAS (^oC)	INDVAR ($^oC^2$)	TBVAR ($^oC^2$)
10	30.0	4.8	0.6	12.3	18.3
20	27.0	2.3	3.3	25.0	
30	26.0	2.6	2.2	16.0	21.9
50	19.4	2.3	1.1	9.6	
70	18.0	1.7	1.7	9.0	
100	10.9	1.0	1.9	7.3	13.3
150	8.7	1.2	0.3	4.0	
200	16.4	1.7	0.7	5.3	
250	11.8	3.6	1.1	10.2	4.8
300	14.1	2.6	1.3	11.6	
400	28.7	2.3	2.6	15.2	
500	36.9	3.6	2.3	11.6	13.1
700	33.5	3.6	-0.1	9.6	
850	42.4	4.4	0.8	13.0	26.8
1000	63.8	9.0	1.6	18.5	70.3
					10.3
300	13.1	3.2	0.9	16.0	10.2
400	21.3	2.0	2.3	20.3	18.1
500	29.3	4.8	2.7	32.5	14.9
700	30.9	10.2	1.2	30.3	22.8
850	44.4	10.2	2.3	56.2	30.2
1000	67.7	11.6	1.7	21.2	33.0
					47.6
	N=37	N=37	45< N< 76		N=37

variances (both CO_2 and H_2O) have increased - specifically, those responding to lower levels of the atmosphere. Brightness temperature variances from moisture channels which are most opaque have decreased; variances from channels which are more transparent (which "see" deeper into the atmosphere) have increased. It is our conclusion from comparison of Tables 2 and 3 that the water vapor channels are too opaque; in a humid, tropical atmosphere, such as the type of C matrix 2, their response is primarily to the water vapor in the mid levels of the atmosphere, where the temperature variance is small. In cold, relatively dry atmospheres, these channels penetrate more deeply toward the surface, and their increased variance is the result of the increased temperature variance at low levels of the atmosphere. The consequence of the vertical shift of the response of the water vapor channels is to introduce a large amount of statistical "noise" to the data set from which the C matrix is to be formed. The systematic correlation between radiosonde temperature/dewpoint reports (treated as truth) and the sensor's response to the radiative signature accompanying such reports becomes much more difficult. One may, of course, consider removing the water vapor radiances from the data set, but only at the cost of removing the water vapor information that is so desirable.

4.2 C-Matrix Variance

One of the essential steps in the formation of a C matrix is the mathematical approximation of the covariance matrices (of both temperature/dewpoint and brightness temperature) by a set of eigenvectors. Each eigenvector accounts for some percentage of the variance of the data being fitted; this percentage may be calculated from the eigenvalues. In Table 4, we have listed the percentage of variance explained by the eigenvectors fitted to the covariance matrices of temperature and dew point (columns 1 and 3) and of brightness temperature (columns 2 and 4). We see (in column 2) that the first eigenvector, which "fits" the covariance of all channels with the window channel (835 cm^{-1}), explains 76% of the variance. The addition of a second eigenvector, fitted to the covariance of all channels relative to a high stratospheric channel (677 cm^{-1}), explains 91% of the variance. The addition of more eigenvectors, associated with the 355 cm^{-1}, 747 cm^{-1}, 353 cm^{-1}, 668 cm^{-1}, and 397 cm^{-1} covariances, explains progressively more of the information content of the sensor channels. Most of this information is in the CO_2 channels. But in column 4, we see that most of the SSH information (53%) is coming from a water vapor channel (355 cm^{-1}).

TABLE 4. VARIANCE REDUCTION BY SUCCESSIVE EIGENVECTORS

SATELLITE 13536				SATELLITE 14537			
C matrix 6				C matrix 2			
T/DP Variance Reduction		Brightness Temperature Variance Reduction		T/DP Variance Reduction		Brightness Temperature Variance Reduction	
20 mb T	55%	835 cm^{-1}	76%	100 mb T	30%	355 cm^{-1}	53%
400 mb T	79%	677 cm^{-1}	91%	10 mb T	51%	668 cm^{-1}	78%
1000 mb T	86%	355 cm^{-1}	98%	300 mb DP	66%	835 cm^{-1}	94%
850 mb DP	91%	747 cm^{-1}	99%	850 mb DP	75%	353 cm^{-1}	98%
700 mb DP	94%	353 cm^{-1}	99%	700 mb DP	82%	708 cm^{-1}	99%
250 mb T	97%	668 cm^{-1}	99+%	500 mb DP	87%	535 cm^{-1}	99+%
200 mb T	98%	397 cm^{-1}	100%	400 mb DP	91%	442 cm^{-1}	100%

Although some information must be derived from the water vapor channels if we are to estimate water vapor profiles, this dominance by the most opaque H_2O channel appears inordinate.

The first and third columns of Table 4 tell us some additional things. In the cold atmospheres of C matrix 6 type, 86 percent of the variance is explained by eigenvectors which fit the covariance between all temperature/dewpoints and the 20 mb temperature, the 400 mb temperature (near the tropopause), and the 1000 mb temperature (i.e., the surface). But in the tropical atmospheres, the covariance relative to 100 mb temperature (tropopause) and 10 mb temperature carries only 51% of the information on the structure of these atmospheres. Covariances with dewpoint temperatures are obviously important in describing the atmospheric structure (about 40%). We also see that the tropical atmosphere is more difficult to describe, since a fixed number of eigenvectors explains a lesser amount of variance than the same number in a cold atmosphere.

4.3 <u>Water Vapor Variance</u>

From the preceeding discussion, the reader may wonder at the regret expressed over the importance of the water vapor channels. From the evidence of columns 1 and 3, it is apparent that water vapor contributes a great deal to the variance of the atmosphere - even the cold atmosphere; it may therefore seem appropriate that the 355 cm^{-1} channel appears near the top in both column 2 and 4 of Table 4. The regret arises from the discrepancy between Table 4 and Table 2. Table 2 says there is little variance in the water vapor channels in humid atmospheres; to extract profile information from the water vapor channels requires a "smarter" C matrix, that is, one which incorporates more <u>covariance</u> information to relate the channels to one another. Building a smarter C matrix takes far more time. To achieve operational capability more quickly, one needs a matrix which better extracts information from individual channels as if they were totally independent - that is, as if they had no covariance at all. (This is equivalent to wishing the channel response or weighting functions to be Dirac delta functions, peaking at fixed heights or pressure levels).

The same point of view - regret over the apparent importance of the water vapor channels - arises from the consideration, based on physical principles, that these water vapor weighting functions must be extremely variable. That they are so is the reason so much covariance information is required. As one

observes greater or lesser amounts of water vapor in these channels, or as the vapor profile changes, the radiant energy measured may originate in very different levels of the atmosphere. As noted above, this complex relationship between temperature structure, humidity structure, and measured radiance may be interpretable through a C matrix with sufficient covariance built into it, but the construction may take some time. It seems preferable to eliminate some of the water vapor channels (at the possible cost of losing some information) and thereby eliminate some of the complexity as well. So long as measurements are to be made with an instrument such as SSH, in which "temperature" channels and "water vapor" channels are so overlapped, a great deal of complexity will always be inherent. One of the several advantages of microwave sounders is that the 60 GHz temperature sounding band is widely separated from - essentially independent of - the 183 GHz H_2O vapor band.

5. SUGGESTED SOLUTIONS

Since additional infrared (SSH-2) sounders will be flying over the next several years, we must attempt to extract the information we need from them. In view of the difficulties noted above, several approaches seem appropriate.

5.1 Increase C-Matrix Covariance

Modify code and coincidence criteria as necessary to capture more data for C matrix construction, i.e., take steps to increase C matrix covariance.

5.2 Eliminate H_2O Channels

Eliminate some or most of the H_2O channels, especially the least independent channels. The choice of channels to be used - and the accessory question of whether different channels should be used in different types of atmospheres - has not been settled.

In an attempt to answer these questions, all satellite 13536 data were combined into formation of a single C matrix. Only two water vapor channels, 535 cm^{-1} and 442 cm^{-1}, were used. The variance of the 188 RAOB measurements is listed in column 1 (TVAR) of Table 5, along with the brightness temperature variance (TBVAR), the variance of the fitted profiles (FITVAR), and the percentage (%) of original variance (TVAR) represented by the remaining variance of the fitted profiles (FITVAR); i.e., the larger the values in the FITVAR and % columns, the worse is the fitted profile in absolute and relative terms.

TABLE 5. SATELLITE 13536

ALL DATA

P (mb)	TVAR	TBVAR	FITVAR	%
10	200		10.3	5
20	152	127	5.8	4
30	118		4.0	3
50	89	109	4.4	5
70	71		4.4	6
100	62	73	4.4	7
150	50		4.4	9
200	48	45	9.6	20
250	45		10.9	25
300	73		7.3	10
400	99	80	6.3	6
500	114		6.3	6
700	130	107	6.3	5
850	147		11.6	8
1000	237	254	15.2	6
300	50		25	50
400	62	55 (441)	29	47
500	73		35	48
700	98		37	37
850	129		35	27
1000	212	118 (535)	18	8
	N = 188	N = 188	N = 188	

Particularly noticeable are the temperature values from 200 to 300 mb, which are very bad in both absolute and relative terms. The reason is not hard to find; variation in tropopause height is relatively large in this part of the atmosphere, between the cold atmospheres and the warm. The absolute error is larger or comparable at the two extremities, 10 mb and 1000 mb, but the relative error is much less. In addition, one expects disagreement between RAOB and satellite at these extremities because of variations in the degree of coincidence ($\pm$ 3 hours, 100 n mi) and the accumulation of error by RAOBs in the upper extremity of their flight (especially due to radiative heating effects). One expects implicitly that the absolute variance of the fitted profiles could be reduced simply by reducing the variance of the original sample used in formation of the C-matrix. Accordingly, the original sample of 188 coincident RAOB-satellite measurements was stratified on the basis of 500 mb temperatures, relative to the 188 sample mean, and two new C-matrices formed. The results are shown in Tables 6 (Cold Data) and 7 (Warm Data), in the format of Table 5.

5.2.1 Cold Data. Comparison of Table 6 with Table 5 shows that the absolute error of the retrievals of cold soundings (i.e., FITVAR) is decreased at every level save the 1000 mb dewpoint (where it remains 18 degrees squared). The error relative to the variance of the coincident RAOB sample is worse at all levels except 100, 150, and 200 mb, but this seems a reasonable exchange to make. If the improvement carries over to independent data, the derived profiles will be more accurate in an absolute sense. If the thesis of preceeding paragraphs is correct - that water vapor variation and its effect on the inversion is the most difficult part of the problem - then this C-matrix should do well with an independent data sample. Examination of the eigenvalues which fit the brightness temperatures shows that the 442 cm^{-1} channel accounts for only slightly more than 1% of the sample variance, and the 535 cm^{-1} channel for less. We further note (in column 2) that the variance of the two water vapor channels used (442 cm^{-1} and 535 cm^{-1}) is relatively large, being 33 and 61 degrees squared, respectively. This might be summarized by saying we expect water vapor - and the signal in the water vapor channels - to have little effect on inversions in cold atmospheres. A greater challenge remains in warm cases, where water vapor is more abundant.

5.2.2 Warm Data. In Table 7 are shown the results of fitting a C-matrix to the warm half (95 samples) of the original 188 RAOB-satellite radiance pairs.

TABLE 6. SATELLITE 13536

COLD DATA

P (mb)	TVAR	TBVAR	FITVAR	%
10	86		8.4	10
20	84	41	4.4	5
30	74		2.9	4
50	61	57	4.0	6
70	49		4.0	8
100	38	41	2.3	6
150	36		2.9	8
200	44		5.8	13
250	24	15	6.8	28
300	16		5.3	33
400	21	24	2.9	14
500	25		4.0	16
700	32	39	5.3	16
850	36		9.0	25
1000	94	104	13.7	15
300	15		8	53
400	20	33 (442)	10	50
500	25		16	64
700	32		21	66
850	44		22	50
1000	97	61 (535)	18	18

N = 93

TABLE 7. SATELLITE 13536

WARM DATA

P (mb)	TVAR	TBVAR	FITVAR	%
10	89		8.4	9
20	56	76	4.8	9
30	49		3.2	6
50	53		2.9	5
70	61	60	2.6	4
100	74		2.9	4
150	56	44	4.0	7
200	40		9.6	24
250	25	12	9.6	38
300	29		7.8	27
400	30	19	6.3	21
500	31		4.8	15
700	34	30	4.4	13
850	47		10.9	23
1000	87	94	16.0	18
300	45		36	80
400	59	21 (442)	38	64
500	65		45	69
700	70	33 (535)	41	59
850	72		44	61
1000	65		15	23
	N = 95			

There are several interesting features in Table 7, some of them anomalous:

a. The relative variance (i.e., the percentage in the last column) has increased at every level except 50, 70, 100, and 150 mb.

b. The absolute variance has decreased at every temperature level except 300 mb and 1000 mb.

c. The absolute variance has increased (gotten worse) at every dewpoint level except 1000 mb, where the improvement is negligible.

d. The variance in the water vapor channels is small (smaller than in the cold atmosphere set, small relative to the RAOB dewpoint variances).

5.2.3 H_2O Channel Selection. In summary, then, we have also achieved an improvement in warm temperature inversions (in absolute terms) by stratifying into cold and warm atmospheres. However, water vapor profiles are worse in the warm atmosphere set - where the water vapor is most abundant. At least the effect of water vapor on the temperature profile part of the problem seems to be reduced; analysis of the eigenvalues of brightness temperature for the warm set indicates only three percent of the variance is being explained by the 442 cm^{-1} channel, and a much smaller percentage by the other vapor channel. This is a major change from the relationship noted in Table 4 and section 4 above, in which the entire inversion matrix was strongly tuned to the multiple water vapor channels. Difficulties in handling the information in the water vapor channels then had a disproportionate effect on the retrieved temperature profile; the tail was wagging the dog, so to speak. The reader may object that the effect of including only two water vapor channels, and those the most transparent, is to amputate the dog's tail. What can be done to better retrieve the vapor information, without allowing the temperature profile to suffer and without an unreasonable burden of computation, will be the subject of follow-on work.

Since 17 February 1980, all on orbit SSH instruments have been inoperable. Tests of new C-matrices, using a reduced set of channels for temperature profiles and a separate set for water vapor profiles, will resume upon acquisition of new data.

6. REFERENCES

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7. GLOSSARY

This glossary is an alphabetical listing of the abbreviations, definitions, etc., used in this Technical Note.

AFGL	-	Air Force Geophysics Laboratory, Hanscom AFB, MASS 01731
DMSP	-	Defense Meteorological Satellite Program
LOWTRAN	-	Low spectral resolution atmospheric transmission simulation model, a product of AFGL/OPI
NEPRF	-	Naval Environmental Prediction Research Facility, Monterey, CA 93940
NESS	-	National Environmental Satellite Service, Washington, D.C. 20233
SET	-	Statistical Eigenvector Technique
SSH	-	Special Sensor H, a multispectral infrared radiometer flown on DMSP satellites
SSMT	-	Special Sensor M/T, a multispectral microwave radiometer flown on DMSP satellites
TIROS	-	Television and Infrared Observation Satellite, a meteorological satellite program directed by NESS
TOVS	-	TIROS Operational Vertical Sounder, a system of multispectral microwave and infrared radiometers flown on TIROS satellites
TSI	-	Technical Development Branch, Technical Services Division, AF Global Weather Central, Offutt AFB, NE 68113